

On page 7, line 14, after "3,914,374," and before "removing", delete "discloses" and insert therefor --disclose--.

On page 7, line 17, after "Example 3" and before "a", delete "passes" and insert therefor --pass--.

On page 8, line 10, after "carbon beds" and before "principally", insert --also--.

On page 9, line 13, after "from suspended," and before "and", insert --solids--.

On page 9, line 13, at the second place, after "The suspended," and before "and", insert --solids--.

On page 9, line 16, after "The suspended," and before "and", insert --solids--.

On page 9, line 20, after "of suspended," and before "or", insert --solids--.

On page 13, line 8, after "stream" and before "with", delete "metal ions".

On page 14, line 16, after "view," and before the period, delete "7 --7" and insert therefor --7--7--.

On page 15, line 22, after "and" and before "for", insert --process--.

On page 17, line 7, after "The" and before "has", insert --collection tank 20--.

On page 17, line 21, after "46," and before "through", insert --and--.

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On page 18, line 16, after "ment," and before the period, delete "column" and insert therefor --in carbon column 60--.

On page 18, line 24, after "column," and before "and", delete "30" and insert therefor --60--.

On page 19, line 20, after "of" and before "operation", delete "continuos" and insert therefor --continuous--.

On page 19, line 22, after "position" and before "and", insert a comma.

On page 20, line 4, after "drain" and before the period, delete "50".

On page 20, line 18, after "solids" and before "for", delete "the fates AWN".

On page 20, line 19, after "the" and before ", then" delete "POTW" and insert therefor --Publicly Owned Treatment Works (POTW)--.

On page 20, line 21, after "reject flow" and before "is used", insert a comma.

On page 20, line 22, after "the" and before "solids", delete "copper free" and insert therefor --copper-free--.

On page 21, line 2, after "concentrated," and before the end of the line, between "copper" and "free", insert a hyphen.

On page 21, line 21, after "view," and before the period, delete "7 --7" and insert therefor --7--7--.

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On page 24, line 21, after "an HTMR" and before "operation", insert --High Temperature Metal Recovery--.

On page 25, line 15, after "is" and before "on-site", delete "position" and insert therefor --positioned--.

On page 30, line 6, after the beginning of the line and before "characteristics", delete "as- received" and insert therefor --as-received--.

On page 39, line 24, after "result" and before "an", delete "os" and insert therefor --of--.

On page 39, line 26, after "Figure" and before "which", delete "6" and insert therefor --9--.

On page 43, line 11, after "12" and before "and", insert a comma.

On page 44, Table 11., delete the entire third column including the third column heading "mg Copper".

REPLACEMENT PARAGRAPHS

In accordance with 37 CFR §1.121(b), delete the indicated paragraphs identified by location as follows and replace the deleted paragraph with the indicated replacement paragraph provided as follows in clean form, i.e., without markings to indicate the changes that have been made.

At page 6, 3rd full paragraph:

Cation selective resins have demonstrated their ability to remove transition metals from solutions containing complexing agents such as gluconates, citrates, tartrates, and ammonia.

B₁ These selective resins are called chelating resins, whereby the ion exchange sites latch onto the transition metal. The chelating resin breaks the chemical bond between the complexing agent or a weaker chelating chemical.

At page 7, 5th full paragraph:

B₂ Koehler et al., U.S. Patent 3,914,374, disclose removing residual copper from acid nickel solutions by activated carbon which absorbs the copper.

At page 7, 6th full paragraph:

B₃ Asano et al., U.S. Patent 3,923,741, in Example 3 pass a copper solution through a granular active carbon column. Flow resistance is measured and reported. The solution then is passed through an ion exchange resin column. (U.S. 3,923,741, Col. 6, lines 35-65.)

At page 8, 2nd full paragraph:

B₄ Conventional pretreatment practice for granular activated carbon beds also principally requires the removal of contaminants such as excess amounts of suspended solids. Suspended solids, including bacteria, in amounts exceeding about 50 mg/l are required to be removed prior to operating the carbon bed.

At page 9, 2nd full paragraph:

B₅ According to Rohm and Haas, the feed must be relatively free from suspended solids and colloidal material. The suspended solids and colloidal matter will form a mat at the surface of the bed. Pressure drop increases, channeling is encountered, and portions of the bed are by-passed. The suspended solids and colloidal matter also coat the beads and granules of the ion exchange resin, reducing the rate of diffusion of ions in and out of the exchanger particle. It is therefore important that all feeds be clarified as much as possible to remove the last traces of suspended solids or colloidal matter. Coagulation, sedimentation, and filtration are the normal clarifying methods.

At page 13, 1st full paragraph:

B₆ The ion exchange unit operation includes means for contacting copper ions in the carbon bed product stream with a chelating ion exchange resin to adsorb the copper ions. In one aspect, the chelating ion exchange resin includes a macroporous iminodiacetic functional group. In one embodiment, the chelating ion exchange resin includes cross-linked polyethylene resin.

At page 14, 7th full paragraph:

B₇ Figure 7 is a top plan view of the process equipment schematic of the process and apparatus of the present invention, taken along view 7--7.

At page 15, 4th full paragraph:

B₈ In one embodiment, the process and apparatus of the present invention provide a novel apparatus and process for the removal of copper ions including passing a wastewater solution containing copper ions first through a carbon adsorption column, preferably without prior micro-filtration or ultra-filtration removal of silica, alumina slurry solids, to remove catalytically the hydrogen peroxide (H₂O₂) and then contacting the wastewater solution containing copper ions with a chelating ion exchange resin of iminodiacetic functional group to attach the copper.

At page 17, 1st full paragraph:

B₉ The collection tank 20 has a nominal retention time of 10 minutes at an influent flow rate of 10 gpm. The copper CMP wastewater contains oxidizers, dissolved copper, copper etchants, alumina particles, silica particles, and some times a corrosion inhibitor. These copper CMP wastewater constituents are contained in a background of deionized (DI) water. The following constituents are common, including dissolved copper, total suspended solids, oxidizing agents, etchants, complexing agents, DI water background 99%+, TDS 800, pH 6 to 7.

At page 17, 2nd full paragraph:

B₁₀ The copper CMP wastewater passes from the collection tank 20 in line 22 and line 24 to a pump 30 and a pump 40, respectively.

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*B10
cont.*

The pumps 30 and 40 provide a duplex pumping station for transferring the wastewater through lines 32 and 42, respectively, at pressures indicated by pressure gauges 32 and 44, through throttling valves 36 and 46, and through lines 38 and 48 to main line 50 at a flow rate of 15 gpm. Five gallons per minute pass in line 52 and are diverted back to the collection tank 20. The remainder of the waste stream (10 gpm) is directed to the process equipment. The 5 gpm of recirculated water maintains a high velocity in the feed tank collection tank 20, which minimizes solids accumulation.

At page 18, 3rd full paragraph:

B11

The wastewater stream in line 50 is passed in line 54, provided by a flexible hose made of a material such as stainless steel nylabraid, to the top of a carbon column 60. The wastewater in line 54 flows at 10 gpm to a peroxide removal pretreatment in carbon column 60. The carbon column 60 contains a specialized coarse grade of activated carbon. The activated carbon is used to remove the hydrogen peroxide. The peroxide pretreatment column is replaced every three months with a fresh column. The carbon column 60 contains granular activated carbon particles sized in the range of about 8 X 40 mesh. A suitable carbon is 8 X 30 mesh acid washed available from U.S. Filter Westates Carbon - Arizona Inc. in Parker, Arizona. The hydrogen

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B11
cont. peroxide of the wastewater stream 54 passes down-flow in the carbon column 60 and is adsorbed onto the granular activated carbon in the carbon column 60.

At page 19, 3rd full paragraph:

B12 The primary or worker ion exchange resin ion exchange column 70 is replaced every 17 to 18 days of continuous operation. The lag or polisher ion exchange column 80 is placed in the primary position, and a freshly regenerated column is placed in the polishing position. The spent ion exchange column is conditioned and regenerated off site at a licensed service facility provided by U.S. Filter Wastewater Group, Inc. of Warrendale, Pennsylvania. A RCRA part B facility is utilized for resin regeneration in the event that the resin is considered a hazardous waste.

At page 20, 1st full paragraph:

B13 Environmentally clean wastewater slurry passes through wastewater ion exchange bed discharge 90 to a municipal drain.

At page 20, 4th full paragraph:

B14 The product water from CRS enters the SSRS collection tank where the waste stream receives an injection of a chemical coagulant. The coagulant feed is optional. The coagulant is used to greatly enhance the recovery rate of the subsequent microfilter. If, however, the intention is to discharge the copper free solids system for subsequent discharge to the publicly

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B14
cont Owned Treatment Works (POTW), then a high microfilter recovery is not desirable.

At page 20, 6th full paragraph:

A nominal 80% recovery for the microfilter is established.

B15 The remaining 20%, resulting from the reject flow, is used to carry away the solids. In such a case, the coagulant feed system can be eliminated.

At page 20, 7th full paragraph:

B16 If it is desirable to eliminate TSS in the reject from the microfilter, a chemical coagulant is utilized. Again the coagulant has the effect of greatly improving the microfilter recovery rate and increasing the flux. The concentrated, copper-free solids are fed to a filter press for de-watering. A recovery rate greater than 95% is achievable. The remaining 5% microfilter blow down is easily de-watered in the filter press.

At page 21, 5th full paragraph:

B17 Referring now to Figure 7, a top plan view is shown of the process equipment schematic of the process and apparatus of the present invention, taken along view 7--7.

At page 24, 3rd full paragraph:

B18 The resin is regenerated at the TSDF (Treatment Storage and Disposal Facility) using recovered hydrochloric acid. The copper chloride then is sold as a by-product, and the hydrochloric acid

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*B18
cont.*
is recovered in an acid recovery unit operation. Alternatively, the copper is precipitated as a metal hydroxide and then recovered in an HTMR High Temperature Metal Recovery operation as elemental copper.

At page 25, 2nd full paragraph:

B19
Copper can be taken up by the resin in the process and apparatus of the present invention at a low pH. It has been found that the process and apparatus of the present invention preferably is positioned on-site at the copper CMP tool facility to avoid aging of the copper CMP wastewater slurry containing copper. In the event of such an on-site process and apparatus of the present invention, the pH may be maintained near neutral. For aged copper CMP wastewater slurry feed solution, a pH of about 2 to 3 provides a good copper uptake on the resin in the process and apparatus of the present invention.

At page 29, 3rd full paragraph:

B20
Three samples were put through the carbon column, "A," "B," and "C," representing different manufacturing companies and separate facilities. One of the samples used during this test was "A" slurry previously concentrated using a Membralox Silver-back® microfilter purification system available commercially from U.S. Filter Wastewater Group, Inc. in Warrendale, Pennsylvania.

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B20
cont. The concentrate was re-diluted with deionized water to simulate "as-received" characteristics.

At page 39, 4th full paragraph:

B21 As a result of an incomplete sample volume, the exhaustion run was terminated and 31.4 ml of the 54 ml of resin was removed for regeneration. The results are shown in Figure 9 which depict an efficient regeneration of the 31.4 ml of resin with 10% HCl. Approximately 100% of the loaded copper was recovered.

At page 43, 1st full paragraph:

B22 A 10% HCl solution was used for the regeneration of the ion exchange column. The test was run for 60 minutes at an average flow rate of 1.39 ml/min. A total volume of 83.4 ml or 2.65 Bed Volumes (BV) was processed through the column. The test was stopped after a low level of copper was detected. Data are shown in Tables 11 and 12, and a regeneration curve is shown in Figure 9.